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HIGH SCHOOL MATHEMATICS TEACHERS' VIEWS ON COMPUTER-ASSISTED MATHEMATICS INSTRUCTION THROUGH COMPUTER ALGEBRA SYSTEMS IN TURKEY

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Abstract:

In this paper, high school mathematics teachers' views on computer-assisted mathematics instruction and on computer algebra systems (CAS) were explored in two stages, before and after they were trained on it. This study is based on the case study model of the qualitative research method. Semi-structured interview forms constitute the data of the study. Some codes and themes were established with the descriptive and content analyses of the data. The results show that teachers had positive opinions about computer-assisted mathematics instruction before they were trained, yet a majority of them was not able to use it in their classes for several reasons. However, it is seen that none of the teachers except for one knew about computer algebra systems (CAS). It is understood after the training that all the teachers wanted to use computer-assisted mathematics instruction in their classes, and thus they needed to use Mathematica, which is a computer algebra system, during the process. Likewise, while most of the teachers did not want their students to interact with computers or tablets in their classes before the computer-assisted mathematics instruction training, almost all of them had a favorable opinion of it after the training.

Keywords: computer-assisted instruction, computer algebra systems, mathematics instruction, teacher's view

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1. Introduction

The rapidly improving technology in our day and the accumulation of knowledge day by day bring into question the necessity to raise a generation who knows what and how to learn and who is conscious of how to reach the truth briefly and to the point instead of direct teaching (Umay, 2004). It requires Information Technologies (IT) in general and computer-assisted instruction in particular to take part in curricula. Computers are surely among the essential materials of educational activities. Improvements in computer technology have led to the use of new and advanced technologies as a requisite for education, and therefore computer technology appears as a system having affirmative roles in students' learning (Gülcü, 2003).

The educational innovations to be introduced by the computer-assisted mathematics instruction should not be ignored in the transition from the general curriculum to the particular mathematics. Together with the technological developments, individuals, who appreciate mathematics, have developed mathematical thinking. Those who can use mathematics for modeling and problem solving are needed more than ever in our world today in which new problems are encountered that the previous generations did not face. New technological tools produced as a result of the technological improvements have directed the practices, research methods and even research questions of mathematicians (Akkoç, 2010). These improvements have also affected mathematics instruction in schools. Especially in the last 30 years, such technological tools as overhead projectors, projectors and interactive whiteboards have begun to be used in mathematics classes (Akkoç, 2010). In addition to these tools, some tools that enable information to be produced, processed, stored, shared and disseminated, all of which are called information technologies, are also employed in mathematics instruction. These information technologies are based on computer technology. Information technologies in mathematics instruction refer, in particular sense, to a sort of mathematics instruction via cognitive tools based on computer, which is called computer-assisted mathematics instruction (Baki, 2006).

Although computer-assisted instruction in Turkey has a history of approximately 35 years, computer has been used as a supportive tool for behavioral approach thus far. Computer has been employed in classes as a demonstration tool supporting teachers' words, which has not banished teacher-centered instruction. However, the application of computers in classes through a structuralist approach can create more fruitful and functional learning environment. In such an environment, students can control their learning through their interaction with computers, can find themselves in different

scenarios via some programs preset by teachers, or can devise their own work with the help of available programs (Baki, 2001; Baki, 2002; Baki, Güven, & Karataş, 2002).

In November 2010, the Movement of Enhancing Opportunities and Improving Technology, known as FATIH Project, was put into practice in schools all around Turkey, and it has been planned to be completed within 5 years. This project aims for equality of opportunity in education, improvement of technology in schools, and for the effective use of ICT tools in teaching-learning process to appeal to more sense organs. The Project intends to provide LCD Interactive Boards and the infrastructure of internet network in all schools, and to distribute every teacher and student tablet PCs. It aims to hold in-service trainings for teachers to maintain their effective usage of ICT equipment in classrooms during learning-teaching process, and aims to form educational e-contents in accordance with ICT-assisted teaching programs (FATIH Project, 2013).

Thus, it would not be unreasonable to say that lack of equipment in schools will be covered in the next years. This assumption also increases the responsibility of teachers who have key roles in the effective application of computer-assisted mathematics instruction in classroom environment. In order for computer-assisted mathematics instruction to be applied efficiently, teachers need to use such computer programs as DGS and CAS, which require more advanced and special training, besides some basic computer programs like word processor and presentation programs.

Ersoy (2005) stated that ICT makes mathematics instruction more complicated than simpler. Taking recent developments into consideration, it is obvious that CAS will be an inevitable and a standard tool for teaching and learning mathematics. Employing such tools as CAS in mathematics instruction will make mathematics more practicable, more desirable and simpler.

The search for perfect and faster operations has led to the emergence of advanced calculators and various computer programs with the developments in mathematics and technology. CAS are the outcome of this search (Tuluk, 2007). CAS, programs which were developed to make symbolic calculations in addition to numerical calculations for the solution of mathematical problems, was created with the expansion of such standard numerical programming languages as C, Pascal and Fortran (Aktümen, 2007). Mathematica, one of the most advanced versions of CAS today, was created by Wolfram Research. Running on "Kernel-front end" logic, it is a broad system which has a graphical user interface, which is easy to enter and edit equations, and which is able to make all kinds of calculations. Apart from its capability to make symbolical calculations and operations with chart objects, one of the most significant features of Mathematica is that it is an expandable system (Gülcü, 2004).

One of the most basic problems in teaching and learning mathematics is that it has an abstract nature (Herzig, 2002; Sarama & Clements, 2009). Computer is also a tool that can instantiate abstract mathematical concepts while it is an advanced calculator (Baki, 1996). Computer-assisted mathematics instruction is the embodiment of this instantiation process in educational environment. According to a high number of researches, mathematics teachers are the main actors in the application of computer-assisted mathematics instruction in classes and in its active place in curricula (Bauer & Kenton, 2005; Öksüz & Ak, 2009; Palak & Walls, 2009; Seferoğlu, Akbıyık & Bulut, 2008; Umay, 2004). In the literature review on the subject, it is pointed out in lots of studies that the main reason for not being able to use computer-assisted mathematics instruction effectively is the incompetence of teachers. It is also suggested in the very studies that teachers should be trained on computer-assisted mathematics instruction to compensate for this lack (Ersoy, 2005; Hangül & Devrim, 2010; Kutluca & Ekici, 2010; Seferoğlu et al., 2008; Yenilmez & Karakuş, 2007).

In Ersoy (2005)'s research on mathematics teachers from state science high schools, it is seen that almost all teachers (92%) agreed that computer-assisted mathematics instruction should be used in order to increase mathematics success in schools. In their research on the views of primary school teachers and primary school prospective teachers about the contribution of computers to the educational process, Seferoğlu et al. (2008) found out that the use of computers helps both groups and provides motivation for students in need of special education.

However, Umay (2004)'s research on the use of ICT in mathematics instruction by primary school teachers and primary school prospective teachers refuted the abovementioned research. In this research, prospective teachers were asked to prepare a one-hour mathematics lesson plan without any restriction. The syllabuses of present teachers were also examined. The results show that none of the present teachers and hardly any of the prospective teachers, except for a few of them, included ICT in their syllabuses.

In a research on the beliefs of mathematics teachers in the application of computer-assisted mathematics instruction, Çakıroğlu, Güven and Karataş (2008) revealed that teachers adopted positive attitude towards the personal and explorative uses of computers though they developed negative attitudes towards computer-assisted mathematics instruction. Most of the teachers believed that computer-assisted mathematics instruction leads students to rote-learning and diminishes in-class interaction. It was construed by researchers that "*the reason why teachers consider computers only for personal uses is that they cannot pedagogically ascribe a role to computers in classes.*"

2. Aim of the Study

This study, unlike the previous researches mentioned above, aims to find out the views of high school mathematics teachers on computer-assisted mathematics instruction, and to train them on it and on Mathematica 9.0 under the title of A Workshop on Computer-Assisted Mathematics Instruction. This study thereupon intends to examine computer-assisted mathematics instruction carried out with CAS. Thus, this study discusses the question "*What are the views of high school mathematics teachers on computer-assisted mathematics instruction carried out with computer algebra systems?*"

3. Method

In this study, qualitative research method is employed to find out the views of high school mathematics teachers on computer-assisted mathematics instruction and CAS in a detailed way. Yıldırım and Şimşek (2008) defined qualitative research method as a method used to present perceptions and incidents in realistic and integrated ways in their natural environments and to provide data collection tools like observation and interview. This research is based on case study model of the qualitative research method because the case study model is a qualitative research design by means of which one or more incidents, environments or interdependent systems are examined in detail (McMillan, 2000), and which aims to analyze one or more cases in an integrated approach within their own boundaries (Yıldırım & Şimşek, 2008).

This research began with the interviews with high school mathematics teachers to find out their views about computer-assisted mathematics instruction. Then, teachers were trained on computer-assisted mathematics instruction under the title of Workshop on Computer-Assisted Mathematics Instruction, which covered applied training of Mathematica 9.0 as part of CAS during the period of 16-hour course. The workshop consisted of the basics of computer-assisted mathematics instruction, the use of Mathematica, and classroom practices of computer-assisted mathematics instruction. After the workshop, some interviews were conducted to find out the views of the participants about computer-assisted mathematics instruction through CAS.

3.1 Participants

The research was composed of 11 mathematics teachers from four different types of high schools in one of the cities of Turkey's Southeastern Anatolia region. Easily accessible sampling method within the scope of the purposeful sampling method was employed so as to determine the participants of the research. The researchers visited

lots of high schools through their own means and resources to determine the participants, and they informed mathematics teachers about their research. Thus, the research was carried out with 11 voluntary high school mathematics teachers.

The average age of the participants is 35, and their professional experience is in the range of 10-15 years. Within the scope of FATIH Project, all the teachers were trained on the use of interactive whiteboards before. Furthermore, one of the teachers was trained on computer-assisted mathematics instruction before through in-service training activities.

3.2 Data Collection and Analysis

In the research, semi-structured interview forms were employed as a data collection tool so as to find out the views of mathematics teachers before and after the workshop (See Appendix A, and Appendix B). While the researchers themselves prepared these semi-structured interview forms, they also received help from three mathematics educators and the related literature (Magolda, 1992; Demir, 2011; Demir & Özmantar, 2013; Leonard, 2001; Taşlıbeyaz, 2010; Yaşar, 2012).

An audio recorder, with participants' permission, was used during the interviews in order to prevent data loss. These recordings were then put on paper by the researchers. Descriptive and content analyses were applied to the data. For Yıldırım and Şimşek (2008), the available data in descriptive analysis is outlined and interpreted according to predetermined themes. Just as the data is organized according to the themes set by the research questions, the data can also be presented with the questions asked during the processes of interview and observation or by taking dimensions into consideration.

The data outlined and interpreted through the descriptive analysis are processed more deeply through the content analysis, which uncovers some concepts and themes that remain unnoticed with the descriptive analysis. The researchers carefully read the interview recordings put on paper, and established some codes with holistic view and themes respectively. These codes were tabulated under the related themes by their percentage and frequency values, and these themes correspond to the titles of the tables as well. Participants were numbered 1 to 11 (T1, T2, …). Some teachers' views, which built the codes, were quoted directly for the sake of the objectivity of the study. Then, these codes and themes were controlled by three mathematics educators, and were revised when needed.

4. Findings and Results

Findings of the research are presented under the relevant categories in tabular form as before and after the Workshop on Computer-Assisted Mathematics Instruction.

4.1Teachers' Responses to What Computer-Assisted Mathematics Instruction Means

The responses of the participants to the question *"What do you think computer-assisted mathematics instruction means?"* were listed under the theme of *"Computer-assisted mathematics instruction"*, and the codes and frequencies in Table 1 were obtained.

Table 1: Computer-assisted mathematics instruction before the workshop

Code	f(%)
Visualization of mathematical concepts	5 (45%)
Use of computer in mathematics instruction as a supportive element	4 (36%)
Interaction between student and computer	3 (27%)
Employment of dynamic materials	2 (18%)
Utilization of computer's processing speed	1 (9%)
Modeling of math problems in computer environment	1 (9%)
Concretization of abstract concepts via computer	1 (9%)

T7's opinion on computer-assisted mathematics instruction as the visualization of mathematical concepts through computer and as the use of computer in mathematics instruction as a supportive element is as follows:

> *"Of the problems of mathematics... I see computer as a supportive element in the transmission of math subjects. …If I teach an integral or a Riemann sum, it is better to do it before students with computer animation than drawing it on the blackboard…"*

T3 expressed his views on the student-computer interaction and the employment of dynamic materials in these words:

"Our smart board is always open; our students have a good tablet; our apps are installed… For instance, a three-dimensional field is ready-made in solid geometry. We extend, restrict, enlarge or reduce it. Computer-assisted mathematics instruction enables students to see all the process or to do the process themselves by trial-and-error. That is, students enter values, and can say such things that the field enlarges at this value or reduces at that value."

When the data obtained from the interviews with teachers after the workshop are examined, it is seen that most of the codes correspond with the codes of the pre-workshop, but differ in frequency (Table 2).

Table 2: Computer-assisted mathematics instruction after the workshop

Code	f(%)
Use of computer in mathematics instruction as a supportive element	7 (64%)
Concretization of abstract concepts via computer	5 (45%)
Visualization of mathematical concepts	4 (36%)
Interaction between student and computer (computer learning)	4 (36%)
Modeling of math problems in computer environment	1 (9%)

T7, who considered computer as a supportive element in computer-assisted mathematics instruction during the first interview, also emphasized student-computer interaction during the second interview:

"I see computer as a supportive element in education; I see that students use computer for getting information as a testing tool. What I mean by getting information is not in the way that 'well students, lets enter that on the Internet and look for what that is' but in the way that students find out knowledge on their own by using such visual programs of prepared substructures as Mathematica, GeoGebra or Cabri."

T1 explained his views on computer-assisted mathematics instruction as the concretization of mathematics as follows:

"I think it is the concretization of mathematics. It is concretization for students. I mean, we can save mathematics from teaching it like a history course or a non-math course through computer-assisted instruction."

Similar to the pre-interview, T11 stated that computer-assisted mathematics instruction is the concretization of various mathematical cases and modeling of them through computer visualization:

"I think that computer-assisted mathematics instruction is the modeling of some problems in concrete terms and transmission of them to the students visually."

4.2 The Benefits of the Use of Computer-Assisted Mathematics Instruction in Math Classes

Teachers' views on the possible benefits of the use of computer-assisted mathematics instruction in classes are discussed under the theme of *"The benefits of the use of computer-assisted mathematics instruction in classes"* (Table 3).

Table 3: The benefits of the use of computer-assisted mathematics instruction in classes before the workshop

Code	f(%)
Providing opportunity to solve more problems	4 (36%)
Visualizing mathematical concepts	4 (36%)
Using class time more efficiently	4 (36%)
Attracting the attention of students	3 (27%)
Being beneficial for evaluation	2 (18%)
Making maths more concrete	2 (18%)
Affecting students' attitude toward maths positively	2 (18%)
Reducing student's workload	2 (18%)
Making maths more memorable	1 (9%)
Dealing with the real-life problems (Simulation)	1 (9%)

T1, who believed that the use of computer-assisted mathematics instruction in classes would provide opportunity to solve more problems and would be beneficial for evaluation because students' activities could be recorded, explained:

"Well, first of all, the use of computer-assisted mathematics instruction makes it clearer indeed while transmitting knowledge to student. Secondly, more applications are

performed. Thirdly, it could be better to evaluate student's applications since they are recorded."

T7's views on the use of computer-assisted mathematics instruction in classes for the visualization of mathematical concepts, for the use of class time more efficiently, and for the simulation of the real-life problems are as follows:

"It only saves time. It enables students to learn visually. Well, let's suppose that you will solve a problem of motion. You can't show it to students as a test through the reflection of daily life, but you can do it on the screen easily."

T2, who stated that the use of computer-assisted mathematics instruction in math classes was attractive for students, explained his ideas in these words:

"I think it really allows for the student to gather his/her attention. Because there is a great interest in computers today, particularly among young people. If we add it to our courses, we can perhaps include distracted students in our classes."

Unlike the interviews carried out before the workshop, the code titled *"Making maths more concrete"* (6 teachers 55%) stands out while the frequency of the code titled *"Providing opportunity to solve more problems"*, which teachers emphasized during the first interview, reduces (Table 4).

Table 4: The benefits of the use of computer-assisted mathematics instruction in classes after the workshop

Code	f(%)
Making maths more concrete	6 (55%)
Visualizing mathematical concepts	5 (45%)
Attracting the attention of students	4 (36%)
Making maths more memorable	3 (27%)
Providing opportunity to solve more problems	1 (9%)
Affecting students' attitude toward maths positively	1 (9%)
Reducing student's workload	1 (9%)
Reducing teacher's workload	1 (9%)

T8's views on the use of computer-assisted mathematics instruction in classes in order to make maths more concrete are revealed below:

> *"Well, for the field of a derivative or an integral, rather than saying 'here you students, this is that's derivative' by taking the derivative, it is better to say 'look students, we've calculated it, let's see what we've calculated'. Here, we make it concrete. It simply works in that way… The moment we show it there, students get enlightened."*

T5, who believed that computer-assisted mathematics instruction made it easier for the students to visualize mathematical concepts, expressed himself in these words:

> *"Students can clearly understand some things when the graph of a function, a cubic function is drawn, or when a sine, cosine function or geometric interpretation of derivative is taught. And they have to see it because you may not be able to have the opportunity and because drawing is not an easy job…"*

T9 stated that computer-assisted mathematics instruction would make mathematics more memorable for students and would reduce teachers' workload:

> "*Teaching with computer-assisted mathematics instruction makes subjects of mathematics more memorable for students at confusing points. What I mean is that it is a format, a system to which students can always apply when they are confused and get their answers whenever they want."*

Students may have such confusing questions. We deal with those questions during the break time or off-class time. It really tires out a mathematics teacher. This Mathematica program will relieve teachers' work by answering such questions.

4.3 Some Possible Problems with the Use of Computer-Assisted Mathematics Instruction in Classes

Teachers' views on some possible problems with the use of computer-assisted mathematics instruction in classes are discussed under the theme titled *"Some problems with the use of computer-assisted mathematics instruction in classes"* (Table 5).

Table 5: Some problems with the use of computer-assisted mathematics instruction in classes before the workshop

Code	f(%)
Difficulty in classroom control	3 (27%)

Problems caused by possible technical disruption	2 (18%)
Inability to use time efficiently	2 (18%)
Activities in computer-assisted mathematics instruction becoming boring for students	1 (9%)
Difficulty in necessary preparation for computer-assisted mathematics instruction	1 (9%)
Possibility of the use of computers/tablets by students as entertainment tools	1 (9%)
Decrease in solving problems	1 (9%)
Passivation of the student	1 (9%)
Distraction for students	1 (9%)
Student's getting used to ready-made things	1 (9%)
Lack of communication between teachers and students	1 (9%)
Lack of compatible software	1 (9%)

T9 expressed that it would be difficult for the teacher to control the classroom in the environment of computer-assisted instruction, and that students could see computers/tablets as entertainment tools:

"It is difficult to prepare students and then to enable them to use computers only for those math programs because students look for games, entertainment and the Internet on computer in the first place when they get it."

T2 stated that technical disruption caused by the breakdown of technological devices would make it difficult for the teacher to control the classroom:

"It shouldn't set loose the students. I mean, we shouldn't get confused in the class about how it works and why it is broken down. Such an event leads to chaos in the classroom. That is, it should never set loose the students and they should be tracked down in a way they can understand."

T5 argued that the use of computer-assisted mathematics instruction would cause a kind of inability to use time efficiently, that students would be bored during the activities in computer-assisted mathematics instruction and that it would lead to decrease in solving problems:

"We are currently busy with solving problems indeed. We believe that the more problems the better. Students also think so. For instance, if we try to teach a sample, a problem or a parabola with computer-assisted mathematics instruction, any single problem will take a whole of the class-time. Both it will bore the students and we will be having played with their future."

The interviews carried out after the workshop reveal that the code titled *"The inability to use time efficiently"* (3 teachers, 27%) stands out while the code titled *"Difficulty in classroom control"* (3 teachers, 27%), which stood out during the interviews conducted before the workshop, is not seen at the interviews done after the workshop (Table 6).

Table 6: Some problems with the use of computer-assisted mathematics instruction in classes after the workshop

Code	f(%)
Inability to use time efficiently	3 (27%)
Student's getting used to ready-made things	2 (18%)
Student's and teacher's lack of sufficient computer knowledge	2 (18%)
Difficulty in getting materials on computer-assisted mathematics instruction	1 (9%)
Distraction for students	1 (9%)
Hindrance to studies on university entrance exam	1 (9%)
Problems caused by possible technical disruption	1 (9%)

T10 stated that computer-assisted mathematics instruction in classes would take too much time and thus would negatively affect students' studies on university entrance exam:

> *"Ministry of National Education is based on testing system, and lessons are delivered in accordance with this testing system. These are programs that take some time. It teaches maths, of course, but I think it will be troublesome in terms of time."*

T5 believed that computer-assisted mathematics instruction would make students get used to ready-made things:

> *"Perhaps, students will get used to ready-made things, and will not exert themselves. For example, when you enter a formula in Mathematica, you can see all of its solutions. And you transfer it to analytic plane or to space. Well, it can both teach students some things and lead them to laziness."*

T1 argued that both teachers' and students' lack of sufficient computer knowledge would hinder the application of computer-assisted mathematics instruction in classes:

"Every student and every teacher must know computer language though little. What I mean by language is the capability to use computer and computer literacy. There may be some shortage of it. These should be overcome."

4.4 The Status of Teachers' use of Computer-Assisted Mathematics Instruction in Math Classes

During the pre-interviews, 6 of 11 teachers (%55) stated that they did not make use of computer-assisted mathematics instruction for several reasons while 5 of the rest (%45) stated they did.

Table 7 and Table 8 indicate about which subjects and on which conditions teachers make use of computer-assisted mathematics instruction in their classes, and from which computer programs they benefit during that process.

Table 7: Subjects on which computer-assisted mathematics instruction are used before the workshop

Code	f(%)
Problem solving	3 (27%)
Functions	1 (9%)
Geometrical figure drawing	1 (9%)
Integrals	1 (9%)
Rigid bodies	1 (9%)
Derivatives	1 (9%)
Pythagoras' theorem	1 (9%)

Table 8: Computer programs benefited from during the process of computer-assisted mathematics instruction before the workshop

Code	f(%)
MS Word	3 (27%)
PDF readers	2 (18%)
StarBoard software	2 (18%)
Websites with appropriate content ("eba.gov.tr" etc.)	2 (18%)
Video and animation players	2 (18%)
Cabri3D	1 (9%)
Geogebra	1 (9%)
MS Powerpoint	1 (9%)
Packaged software from private publishers	1 (9%)

T6 pointed out that he used computer-assisted mathematics instruction in his classes by means of MS Word and PDF reader:

"I currently use it… But we mean it for problems, I give the problems… For example, we have the books in PDF. I select some examples from those books, copy them on MS Word file, and present them to students. On the other hand, if I solve problems from the coursebook, I project its image on the wall since students also have the coursebook…"

T4 revealed that he used computer-assisted mathematics instruction for the subject of functions through a video on www.eba.gov.tr:

"The last time, I got high school students to watch some videos on functions which I downloaded on EBA. There was a cafe called "logic" in the video to give the definition. Students listened to it very carefully there and comprehended it immediately. … It was a video with face-to-face conversations."

T8 explained that he used computer-assisted mathematics instruction for geometrical figure drawing by means of some packaged software and StarBoard software:

"I use smart board. I utilize drawings. A circle is drawn easily, for instance, or a triangle. I make use of aforementioned software. Packaged and StarBoard."

T7 said that he used computer-assisted mathematics instruction for teaching integral, Pythagoras' theorem, rigid bodies and derivatives through Cabri3D snd GeoGebra software:

"I employed Cabri3D in geometry classes last year. I practiced Pythagoras' theorem and else. I expanded rigid bodies… For example, as to the geometric interpretation of derivatives, we scrolled lines manually, which was hard for students to get it. But I prepared an animation on GeoGebra. It was seen that students began to understand easily. They easily got that the value of a derivative at a certain point is the slope of a tangent drawn at that point…"

The data on the reasons why computer-assisted mathematics instruction was not used in classes, which was obtained from the interviews with teachers (6 teachers, 55%) who did not use computer-assisted mathematics instruction in their classes, are discussed under the theme of *"The reasons why computer-assisted mathematics instruction is not used in classes"* and the related codes are given in Table 9.

Table 9: The reasons before the workshop why computer-assisted mathematics instruction is not used in classes

Codes	f(%)
Absence of training on computer-assisted mathematics instruction	4 (36%)
Absence of the knowledge of utilities of computer-assisted mathematics instruction	3 (27%)
Hindrance to studies on university entrance exam	2 (18%)
Unawareness of the effect of computer-assisted mathematics instruction on students	1 (9%)
Absence of computer-assisted mathematics instruction software	1 (9%)
Reluctance of students	1 (9%)
Absence of sufficient computer knowledge	1 (9%)

T9 expressed that he was not able to use computer-assisted mathematics instruction in classes on the grounds that he did not have any training on it:

"Well, we make use of computers themselves rather than computer-assisted mathematics. I mean, not of computer's maths. Why not? Because we haven't been trained on it, either. We fall short of it."

T10 explained that he could not use computer-assisted mathematics instruction in classes owing to the absence of the knowledge of utilities of computer-assisted mathematics instruction, the unawareness of the effect of computer-assisted mathematics instruction on students, and to the absence of computer-assisted mathematics instruction software at present:

"First of all, we haven't been trained on the program. Plus we don't have the necessary infrastructure for it either at school or on our own computers. Well, we haven't been given any feedback before on whether it is helpful for students or not. So we cannot use it."

T2 revealed that he did not use computer-assisted mathematics instruction in his classes because it would hinder students' studies on university entrance exam and because he did not have sufficient computer knowledge:

"Firstly, I'm not a computer literate. Secondly, the available testing system… Solving more problems requires being fast. Perhaps we'll be faster if we know how to use computer well. Actually, we don't prefer to use computer-assisted mathematics instruction lest it hinders students because we are not able to use computer well enough.

We prepare students for YGS-LYS (Higher Education Examination-Undergraduate Placement) straightly. …To tell the truth, we are not interested."

T5 told that he had made use of smart board for a while but he had left it because students did not want it, so he had not used computer-assisted mathematics instruction in classes since then:

"I began to teach on smart board for a semester last year… But when I made a survey at the end of the term, I saw that students did not want it as the survey says. …Students sometimes used to say, 'Oh teacher, please you tell' and something like this, which was a general tendency of students at that time."

Teachers' answers to the question *"Do you consider using computer-assisted mathematics instruction in your classes after this process (after the workshop)?"*, which was asked to them after the workshop, are discussed under the theme of *"The use of computer-assisted mathematics instruction in classes"*, and it is seen that all the teachers (100%) stated positive opinion.

T10, who had previously stated that he could not use computer-assisted mathematics instruction in classes due to his lack of software knowledge, uttered after the workshop that he would use it thereafter:

"I definitely consider using it hereafter. Why? Even during the basic training, we have seen how to do operations at some points and how some programs could help us at some confusing parts. I also believe that students will fondly learn maths and will solve problems by feeling them. That is why I certainly want to use it."

It is seen during the pre-interview that only one teacher (T7) among the teachers (5 teachers, 45%) who asserted that they used computer-assisted mathematics instruction in their classes actually made use of mathematical software. Answers of the teachers (all of them), who considered using computer-assisted mathematics instruction in their classes, to the question *"Which computer software do you consider applying during this process?"*, which was asked to them after the workshop, are discussed under the theme of *"Computer software to be applied for the computer-assisted mathematics instruction"*, and Table 10 shows the related codes:

Table 10: Computer software to be applied for the computer-assisted mathematics instruction after the workshop

Code	f(%)
I consider applying Mathematica	9 (82%)
I consider applying Mathematica after I improve myself on it	2 (18%)
I consider applying GeoGebra	2 (18%)

T8, who explained that he had previously met GeoGebra through T7, a colleague at the same school, but could not apply it because he did not know how to use it, expressed after the workshop that he would apply Mathematica for the computer-assisted mathematics instruction:

> *"For now, I know Mathematica best. We, T7 and me, have never thought about GeoGebra seriously. He used to show some drawings only. I believe I can do it now. I want to apply it next year in my classes not all the time but if need be and if there is enough time."*

T7, who indicated that he had applied GeoGebra in classes before, pointed out that he wanted to apply Mathematica this time, but he thought that he had to improve himself on the program in the first place:

> *"I consider applying Mathematica, not in the amateur status but semi-professionally."*

T5, who had met GeoGebra before during the in-service training, put that he would apply both Mathematica and GeoGebra for the computer-assisted mathematics instruction:

> *"GeoGebra could also be applied effectively. Mathematica could be applied as well. We have been trained on it before, but we forget it immediately because we don't use it. I think it is better to use because this is an era of technologies. Children are born and grown up among the technological conveniences. They know computers better than us. It seems to me that they will comprehend it better."*

4.5 Teachers' Views on Students' Use of Computer/Tablet with Compatible Software in Classes

Teachers' answers to the question *"What is your opinion on students' use of computers or tablets with compatible software in your mathematics and geometry classes?"*, which was

asked during the pre-interview, are discussed under the theme of *"Students' use of computer/tablet in classes"* (Table 11). While 6 of the teachers (55%) gave positive opinion, 5 of them (45%) gave negative opinion for several reasons.

Table 11: Students' use of computer/tablet in classes before the workshop

Code	f(%)
It will be helpful to use	6 (55%)
Computers/tablets will be used by students as entertainment tools	1 (9%)
Students will not comprehend process steps	1 (9%)
It will not be used due to intensive curriculum	1 (9%)
It will distract students	1 (9%)
It will make classroom management harder	1 (9%)
It will hinder students' studies on university entrance exam	1 (9%)

T9 expressed that it would be helpful for students to use computer/tablet in classes:

> *"I think computer has considerable influence on education, so I want it to be used. However, we need to have some background in it. These programs should be prepared beforehand. I mean, we should set contents of the courses firstly. I believe it will be really helpful if these are all done."*

T1 pointed out that students would use tablets as entertainment tools, and thus it would make classroom management harder:

> *"It will cause some troubles; it will be really difficult for us as teachers to draw their attention to the course. … Students will use tablets as entertainment tools. Well, every student needs to be kept under control both in the classroom and outside the school remotely."*

T2 believed that students' use of computer/tablet during the courses would prevent them from comprehending process steps of maths:

> *"I believe it is more appropriate for students to follow the subject on the blackboard because we proceed step by step in maths. … Besides, students could be appalled by all the processes presented to them at a single time. They can have some difficulty in understanding them."*

It is seen at the interviews conducted after the workshop that nearly all the teachers (10 teachers, 91%) gave the opinion that "It will be helpful to use" when their answers to the question *"What do you think about the fact that students use computers or tablets with some activities prepared through CAS in your maths and geometry courses?"* is examined.

Table 12: Students' use of computer/tablet in classes after the workshop

Code	f(%)
It will be helpful to use	10 (91%)
It cannot be used for several reasons	1 (9%)

T2, who had previously stated that students' use of computer/tablet during the courses would prevent them from comprehending process steps of maths, believed after the workshop that use of computer/tablet would be helpful for students:

> *"I believe it will be effective. I consider it positively at least in the way that students don't get distracted and bored. They will probably be more involved in courses. Since students are very interested in computers, they can also work with them extracurricularly and find out something new."*

T5 explained that computers/tablets should not be used in classes on the grounds that students could use them for entertainment:

> *"Our students haven't developed the awareness of computers and tablets as study materials. They are keener to use them for entertainment and for games. It will be helpful only if a new curriculum is developed for their use in class environment."*

5. Discussion

5 of the mathematics teachers (45%) indicated before the workshop that they used computer-assisted mathematics instruction in their classes. It was seen during the interviews that 3 of these teachers only used it to solve problems on smart boards, and 1 of them used it to get students to watch instructional videos. It is possible to state under these circumstances that ICT were used in classes at a very basic level, which allowed for a kind of medium change in classes merely. Besides, only one of the teachers expressed that he made use of DGS and CAS in classes. Yet, the interaction between students and computers, which is a key element in computer-assisted mathematics

instruction, has not been taken into consideration in both cases. Therefore, it could be said that teachers regarded computer-assisted mathematics instruction, before the workshop, as a teacher-centered instruction, which is an extension of behavioral approach. This case in question has been referred several times in other relevant studies (Baki, 2001; Baki, 2002; Baki, Güven, & Karataş, 2002; Bauer & Kenton, 2005; Palak & Walls, 2009).

All the teachers (100%) revealed after the workshop that they all wanted to use computer-assisted mathematics instruction in their classes. Similarly, 9 of the 11 teachers (82%) uttered at the interview conducted after the workshop that they wanted to apply Mathematica, which is a CAS software, in their classes while the rest of them (2 teachers, 18%) explained that they wanted to apply Mathematica in their classes only after they improved themselves on it. It is seen by these results that mathematics teachers believe that application of CAS in classroom environment will be effective both for teachers and students.

Recently in Turkey, the Ministry of National Education has been distributing tablets to students within the scope of the FATIH Project. It is found out during the interviews carried out by taking the present circumstances into account that 6 of the 11 teachers (55%) thought before the workshop that it would be helpful for students to use computers/tablets in classes while 10 of them (91%) did so after the workshop.

That a great majority of the teachers gave positive opinion after the workshop on the application of computer-assisted mathematics instruction through CAS in their classes and on students' use of computers or tablets during this process could be interpreted as the recognition of the student-computer interaction and as the adoption of the student-centered instruction. Teachers' positive change after the workshop in the employment of ICT and the application of computer-assisted mathematics instruction in their classes corresponds to Ersoy (1996)'s findings about the positive attitudes of teachers developed after their attendance at in-service training on the use of technology in classes. In a similar way, the findings of Yılmaz and Güven (2011) about primary mathematics teachers' developing positive attitude toward computer-assisted mathematics instruction after the in-service training during which they met Cabri, Graphic analysis, Derive and Geogebra programs also support the result of this study. Moreover, teachers' positive opinions of computer-assisted mathematics instruction in this study share some similarities with other studies that take place in literature and focus mostly on the views and perceptions of prospective teachers (Alakoç, 2003; Baki, 2000; Corbalan, Paas, & Cuypers, 2010; Pierce, Ball, & Stacey, 2009; Kutluca & Birgin, 2007; Marshall, Buteau, Jarvis, & Lavicza, 2012; Usluel & Umay, 2005; Yavuz & Can, 2010; Tatar, Akkaya, & Kağızmanlı, 2011).

6. Conclusion

When the findings of the study are examined as a whole, it is seen that teachers are willing to teach through computer-assisted mathematics instruction if the physical conditions of schools are improved in accordance with computer-assisted mathematics instruction and if teachers are trained on it appropriately. It can be done just like the in-service training carried out during the placement of smart boards in classrooms. Unlike the former process, the training should not be limited to the technical features of the technological products or to their guidelines. Teachers should be trained on computer-assisted mathematics instruction itself during those in-service trainings. Some experts on computer-assisted instruction are needed in this process to train and guide teachers specific to their field of study. In addition to its contribution to literature with increasing qualitative and quantitative researches involving mathematics teachers particularly, computer-assisted mathematics instruction is also significant for its application in classes. Last but not least, prospective teachers at faculties of education could also be trained on computer-assisted mathematics instruction and ICT, which began to take place as part of the FATIH Project.

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Appendix

A. Interview Questions Asked before the Workshop on Computer-Assisted Mathematics Instruction

1. What do you think computer-assisted mathematics instruction means?
2. What do you think about the benefits of using computer-assisted mathematics instruction in classes?

3. What can be the problems with the use of computer-assisted mathematics instruction in classes?
4. Do you use computer-assisted mathematics instruction in your classes?

- If your answer is yes;
  - Could you give an example, please?
  - Which computer programs do you make use of?
- If your answer is no;
  - What are the reasons why you do not use computer-assisted mathematics instruction in your classes?

5. What is your opinion on students' use of computers or tablets with compatible software in your mathematics and geometry classes?

B. Interview Questions Asked after the Workshop on Computer-Assisted Mathematics Instruction

1. What do you think computer-assisted mathematics instruction is?
2. What do you think about the benefits of using computer-assisted mathematics instruction in classes?
3. What can be the problems with the use of computer-assisted mathematics instruction in classes?
4. Do you consider using computer-assisted mathematics instruction after this process (after the workshop?
   - If your answer is yes;
     - Which computer programs will you make use of?
   - If your answer is no;
     - What are the reasons why you do not want to use computer-assisted mathematics instruction in your classes?
5. What is your opinion on students' use of computers or tablets with activities prepared through CAS (e.g. Mathematica) in your mathematics and geometry classes?

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